

CLAIMS

I/We claim:

- [c1] 1. An apparatus for carrying an unmanned aircraft, comprising:
a support;
a launch carriage movably carried by the support;
a gripper movably coupled to the launch carriage, the gripper including at least one grip portion positioned to releasably engage an unmanned aircraft, the gripper being movable relative to the launch carriage between a first position with the at least one grip portion positioned to contact the aircraft and a second position with the at least one grip portion positioned to be out of contact with the aircraft; and
a brake positioned at least proximate to the gripper, the brake being changeable from a first configuration in which the brake inhibits motion of the gripper by a first amount, and a second configuration in which the brake does not inhibit motion of the gripper, or inhibits motion of the gripper by a second amount less than the first amount.
- [c2] 2. The apparatus of claim 1 wherein the brake includes a first brake member and a second brake member, with at least one of the brake members being movable relative to the other.
- [c3] 3. The apparatus of claim 1 wherein the brake includes a first brake member coupled to the carriage and a second brake member coupled to the at least one grip portion, and wherein the second brake member is rotatable about an axis and translatable along the axis between a first position relative to the first brake member and a second position relative to the first brake member.

- [c4] 4. The apparatus of claim 1 wherein the gripper includes at least one grip portion positioned to releasably engage a fuselage of the aircraft, the gripper being movable relative to the launch carriage between a first position with the at least one grip portion positioned to contact the fuselage and a second position with the at least one grip portion positioned to be out of contact with the fuselage.
- [c5] 5. The apparatus of claim 1 wherein the gripper includes two gripper arms pivotally coupled to the launch carriage, the individual gripper arms including at least one grip portion positioned to releasably engage the fuselage of the aircraft.
- [c6] 6. The apparatus of claim 1 wherein the gripper is movable between the first and second position when the launch carriage decelerates relative to the support.
- [c7] 7. The apparatus of claim 1 wherein:
the launch carriage is movable relative to the support along a launch axis;
and
the gripper is pivotable relative to the launch carriage about a pivot axis offset from the launch axis to pivot downwardly and outwardly away from the launch axis as the gripper moves from the first position to the second position, and wherein at least a portion of the mass of the gripper is eccentrically offset from the pivot axis to swing the gripper from the first position to the second position as the carriage decelerates.
- [c8] 8. The apparatus of claim 1, further comprising the aircraft.

[c9] 9. The apparatus of claim 1 wherein the support includes a launch guide structure having a launch axis, and wherein the launch carriage is movable relative to the support along the launch axis.

[c10] 10. An apparatus for carrying an unmanned aircraft, comprising:
a support;
a launch carriage movably carried by the support;
a gripper movably coupled to the launch carriage, the gripper including at least one grip portion positioned to releasably engage an unmanned aircraft, the gripper being movable relative to the launch carriage between a first gripper position with the at least one grip portion positioned to contact the aircraft and a second gripper position with the at least one grip portion positioned to be out of contact with the aircraft; and
a gripper brake positioned proximate to the gripper, the gripper brake including a first brake portion carried by the launch carriage and a second brake portion carried by the gripper, the second brake portion being movable relative to the first brake portion between a first brake position and a second brake position, with the second brake portion in contact with the first brake portion and applying a first force to the first brake portion when in the first position, and with the second brake portion out of contact with the first brake portion or applying a second force less than the first force when in the second position.

[c11] 11. The system of claim 10 wherein the first brake portion is configured to rotate about an axis and translate along the axis between the first and second positions.

[c12] 12. The system of claim 10 wherein the first brake portion is coupled to a first threaded member and the second brake portion is coupled to a second threaded member that is threadably engaged with the first threaded member.

[c13] 13. The system of claim 10 wherein the first brake portion is coupled to a first threaded member and the second brake portion is coupled to a second threaded member that is threadably engaged with the first threaded member, and wherein the second threaded member is movable relative to the gripper to adjust an axial separation between the first and second brake portions.

[c14] 14. An apparatus for carrying an unmanned aircraft, comprising:
carriage means for carrying an unmanned aircraft during launch;
support means for supporting and guiding the carriage means along a launch axis during takeoff;
gripper means for releasably carrying an unmanned aircraft, the gripper means being movable relative to the carriage means between a first position with the gripper means positioned to contact the aircraft and a second position with the gripper means positioned to be out of contact with the aircraft; and
brake means for at least impeding motion of the gripper means relative to the carriage means.

[c15] 15. The apparatus of claim 14 wherein the brake means includes a first brake portion and a second brake portion, the second brake portion be rotatable about an axis relative to the first brake portion and movable along the axis toward and away from the first brake portion as it rotates.

[c16] 16. The apparatus of claim 14 wherein the gripper means includes a gripper having at least one gripper arm pivotally coupled to the launch carriage,

the at least one gripper arm carrying the at least one grip portion positioned to releasably engage the fuselage of the aircraft.

[c17] 17. The apparatus of claim 14 wherein the gripper means is pivotable relative to the carriage means about a pivot axis offset from the launch axis to pivot downwardly and outwardly away from the launch axis as the gripper means moves from the first position to the second position, and wherein at least a portion of the mass of the gripper means is eccentrically offset from the pivot axis to swing the gripper means from the first position to the second position as the carriage means decelerates.

[c18] 18. An apparatus for launching an unmanned aircraft, comprising:
a first launch member;
a second launch member positioned at least proximate to the first launch member; and
a launch carriage having an aircraft support positioned to releasably carry an unmanned aircraft during a takeoff operation, the launch carriage having a first portion in contact with the first launch member and a second portion in contact with the second launch member, wherein the launch carriage is movable relative to the launch members between a first launch carriage location and a second launch carriage location as at least one of the first and second launch members moves relative to the other, or as at least one of the carriage portions moves relative to the other, or both.

[c19] 19. The apparatus of claim 18 wherein the launch carriage moves in a first direction between the first launch carriage location and the second launch carriage location, and wherein the at least one launch member moves in a second direction transverse to the first direction between a first position and a second position.

- [c20] 20. The apparatus of claim 18 wherein the launch carriage moves in a first direction between the first launch carriage location and the second launch carriage location, and wherein the at least one carriage portion moves in a second direction transverse to the first direction between a first position and a second position.
- [c21] 21. The apparatus of claim 18, further comprising a support structure, and wherein the first and launch members are carried by the support structure.
- [c22] 22. The apparatus of claim 18, further comprising an actuator coupled to the at least one launch member, the at least one carriage portion, or both.
- [c23] 23. The apparatus of claim 18, further comprising an actuator coupled to the at least one launch member, the at least one carriage portion, or both, and wherein the actuator includes at least one of a hydraulic cylinder, a spring, a pneumatic cylinder, and an electric motor.
- [c24] 24. The apparatus of claim 18 wherein at least one of the first and second launch members includes a braking portion, and wherein the braking portion is positioned to contact and decelerate the launch carriage as the launch carriage moves from the first launch carriage location to the second launch carriage location.
- [c25] 25. The apparatus of claim 18 wherein at least one of the first and second launch members includes a curved portion, and wherein the curved portion is shaped to provide constant acceleration to the launch carriage as the launch carriage moves from the first launch carriage location to the second launch carriage location.

- [c26] 26. The apparatus of claim 18 wherein:
the first launch member includes a first roller surface and the second launch member includes a second roller surface non-parallel to the first roller surface; and
the launch carriage includes a first wheel in rolling contact with the first roller surface and a second wheel in rolling contact with the second roller surface.
- [c27] 27. The apparatus of claim 18 wherein the first launch member includes a first surface in contact with the launch carriage, and wherein the second launch member includes a second surface in contact with the launch carriage, the second surface having a first portion oriented at a first angle relative to the first surface to accelerate the launch carriage, the second surface having a second portion oriented at a second angle relative to the first surface to decelerate the launch carriage, the second angle being different than the first angle.
- [c28] 28. The apparatus of claim 18 wherein the first launch member includes a first roller surface and the second launch member includes a second roller surface non-parallel to the first roller surface, and wherein the angle between the first and second roller surfaces is greater when the launch carriage is in the second launch carriage location than when the launch carriage is in the first launch carriage location.
- [c29] 29. The apparatus of claim 18, further comprising the unmanned aircraft.
- [c30] 30. An apparatus for launching an unmanned aircraft, comprising:
a first launch member;
a second launch member positioned at least proximate to the first launch member; and

a launch carriage having an aircraft support positioned to releasably carry an unmanned aircraft during a takeoff operation, the launch carriage having a first portion in contact with the first launch member and a second portion in contact with the second launch member, the launch carriage being movable relative to the launch members between a first launch carriage location and a second launch carriage location as at least one of the carriage portions moves relative to the other.

[c31] 31. The apparatus of claim 30 wherein the first launch member includes a first track and wherein the second launch member includes a second track, with at least a portion of the first track being non-parallel to the second track.

[c32] 32. The apparatus of claim 30 wherein the first portion of the launch carriage includes first pulleys and the second portion of the launch carriage includes second pulleys, and wherein the apparatus further comprises:

an elongated flexible transmission member engaged with the first and second pulleys; and

an actuator operatively coupled to the transmission member to apply tension to the transmission member and draw the at least one carriage portion toward the other.

[c33] 33. An apparatus for launching an unmanned aircraft, comprising:
carriage means for supporting an unmanned aircraft during a takeoff operation, the carriage means having a first carriage portion and a second carriage portion; and

support means for supporting the carriage means, the support means having a first support portion and a second support portion, wherein at least one of the carriage portions is movable relative to the other to accelerate the carriage means relative to the support means, or at

least one of the support portions is movable relative to the other to accelerate the carriage means relative to the support means, or both.

[c34] 34. The apparatus of claim 33 wherein the support means includes a first launch member in contact with the first carriage portion and a second launch member in contact with the second carriage portion, and wherein at least a portion of the first launch member in contact with the first carriage portion is non-parallel to at least a portion of the second launch member in contact with the second carriage portion.

[c35] 35. An apparatus for launching an unmanned aircraft, comprising:
a first launch member;
a second launch member positioned at least proximate to the first launch member;
a launch carriage having a first portion in contact with the first launch member and a second portion in contact with the second launch member, the launch carriage being movable relative to the launch members between a first launch carriage location and a second launch carriage location as at least one of the carriage portions moves relative to the other;
a gripper movably coupled to the launch carriage, the gripper including at least one grip portion positioned to releasably engage an unmanned aircraft, the gripper being movable relative to the launch carriage between a first position with the at least one grip portion positioned to contact the aircraft and a second position with the at least one grip portion positioned to be out of contact with the aircraft; and
a gripper brake positioned at least proximate to the gripper, the gripper brake being changeable from a first configuration in which the gripper brake inhibits motion of the gripper by a first amount, and a

second configuration in which the gripper brake does not inhibit motion of the gripper, or inhibits motion of the gripper by a second amount less than the first amount.

[c36] 36. The apparatus of claim 35 wherein at least a portion of the first launch member is non-parallel to at least a portion of the second launch member.

[c37] 37. The apparatus of claim 35, further comprising an actuator operatively coupled to the launch carriage to move the at least one carriage portion relative to the other.

[c38] 38. The apparatus of claim 35, further comprising an actuator operatively coupled to the launch carriage to move the at least one carriage portion relative to the other, and wherein the actuator is carried by the launch carriage.

[c39] 39. The apparatus of claim 35, further comprising an actuator operatively coupled to the launch carriage to move the at least one carriage portion relative to the other, and wherein the actuator is not carried by the launch carriage.

[c40] 40. A method for launching an unmanned aircraft, comprising:
releasably supporting an unmanned aircraft with a launch carriage;
releasably engaging the aircraft with a gripper carried by the launch carriage;
accelerating the launch carriage along a launch axis;
disengaging the gripper from the aircraft by moving the gripper relative to the launch carriage from a first position to a second position;
releasing the aircraft from the launch carriage for flight; and

at least restricting motion of the gripper relative to the launch carriage after disengaging the gripper.

[c41] 41. The method of claim 40 wherein at least restricting motion of the gripper relative to the launch carriage includes engaging two brake portions with each other, with one brake portion being movable with the gripper.

[c42] 42. The method of claim 40 wherein at least restricting motion of the gripper relative to the launch carriage includes rotating one brake portion about an axis and moving the one brake portion along the axis into contact with another brake portion.

[c43] 43. The method of claim 40 wherein the launch carriage includes a first brake portion and the gripper includes a second brake portion and wherein at least restricting motion of the gripper relative to the launch carriage after disengaging the gripper includes rotating the second brake portion about an axis and moving the second brake portion along the axis to contact the first brake portion as the gripper rotates relative to the launch carriage.

[c44] 44. The method of claim 40 wherein the launch carriage includes a first brake portion coupled to a first threaded member and the gripper includes a second brake portion coupled to a second threaded member and threadably engaged with the first threaded member, and wherein at least restricting motion of the gripper relative to the launch carriage after disengaging the gripper includes rotating the second brake portion about an axis and moving the second brake portion along the axis to contact the first brake portion as the gripper rotates relative to the launch carriage, and wherein the method further comprises:
decoupling the second threaded member from the gripper portion; and

rotating the second threaded member relative to the gripper portion to adjust a clearance between the first brake portion and the second brake portion.

[c45] 45. The method of claim 40, further comprising decelerating the launch carriage to move the gripper from the first position to the second position.

[c46] 46. The method of claim 40 wherein releasably engaging the aircraft with the gripper includes releasably engaging a fuselage of the aircraft with the gripper.

[c47] 47. The method of claim 40 wherein the gripper includes at least one gripper arm pivotally coupled to the launch carriage, and wherein moving the gripper from a first position to a second position includes rotating the at least one gripper arm downwardly and outwardly away from a longitudinal axis of the aircraft.

[c48] 48. A method for launching an unmanned aircraft, comprising:
releasably supporting an unmanned aircraft with a launch carriage, the launch carriage being movably carried by and in contact with a first launch member and a second launch member;
accelerating the launch carriage from a first launch carriage location to a second launch carriage location by moving at least one of the first and second launch members relative to the other while the launch members contact the launch carriage, or by moving at least one portion of the launch carriage relative to another while the launch members contact the launch carriage, or both; and
releasing the unmanned aircraft from the launch carriage for flight.

[c49] 49. The method of claim 48 wherein at least a portion of the first launch member is non-parallel to at least a portion of the second launch member, and wherein accelerating the launch carriage includes moving the at least one launch member away from the other.

[c50] 50. The method of claim 48 wherein at least a portion of the first launch member is non-parallel to at least a portion of the second launch member, and wherein accelerating the launch carriage includes moving the at least one carriage portion toward the other.